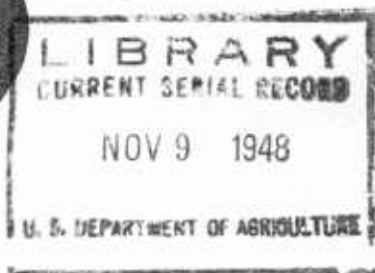


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Raspberry Culture



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U. S. DEPARTMENT OF AGRICULTURE

RASPBERRIES are grown both in small plantations for home use and local markets and in some sections as the principal commercial crop. In such sections raising raspberries has become highly specialized and methods peculiar to the industry are used.

Growers with limited experience in raspberry culture should get better results by following the methods of planting, cultivating, and training and pruning described in this bulletin, especially the practices that differ from those used for other bush fruits. Red raspberries are planted on the hill, hedge, and linear systems, whereas black raspberries are usually planted on the linear system. The method of pruning and training depends upon the method of planting, the section, and the variety. The practices discussed should, of course, be modified as necessary to meet local conditions.

Growers can select from the varieties described the ones adapted to their locality, market, and season, including the fall-fruited varieties.

RASPBERRY CULTURE

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INTRODUCTION

RASPBERRIES of three types (red, black, and purple) are grown extensively in the United States. Red raspberries bear red fruit, have erect canes, and usually are propagated by suckers, which come from the roots of the parent plant. A very few of the varieties under cultivation come from the European wild red raspberry (*Rubus idaeus* L.), and the rest come from the American wild red raspberry (*R. idaeus* var. *strigosus* (Michx.) Maxim.) or are hybrids of these two types. Among the leading red varieties are the Latham, Cuthbert, Taylor, and Washington.

Black raspberries, or blackcaps, bear black fruit, have arched canes, which root at the tips in the fall, and are propagated by the plants formed at the tips. All black varieties come from the American black raspberry (*Rubus occidentalis* L.), which grows wild in the eastern United States. Under cultivation, however, they are not so hardy as some of the red varieties that come from the American wild red raspberry. The Cumberland is by far the most important commercial sort of the black type.

The varieties under cultivation bearing purple fruit are hybrids between the red and black raspberries and have canes that arch and root at the tips, as do the black raspberries. The Columbian and Sodus are leading purple sorts.

Occasionally plants of the red, purple, and black types are found to bear yellow fruit, but the yellow varieties in cultivation belong to the red-fruited type. The Golden Queen is the leading yellow-fruited variety. It is rarely grown for the general market but is adapted to home gardens and to special markets.



Figure 1.—A fruit cluster of a red raspberry. The clusters of red varieties differ greatly in the ease with which the berries are seen and picked, being readily seen in the Latham and hidden in the Sunrise.



Figure 2.—A fruit cluster of the Cumberland black raspberry. Contrast the stiff, prickly fruit stems shown here with the slender, drooping stems of the red raspberry shown in figure 1.

Figures 1 and 2 show the difference between the fruit cluster of red and black varieties.

The cultivation of the raspberry is limited largely to the northern United States, chiefly to those sections where the wild raspberries grow most abundantly. Since the introduction of the Ranere, commercial raspberry plantings have succeeded as far south as Atlanta, Ga.

The red-raspberry districts from which extensive shipments are made are located in western Maryland, in southern New Jersey, in the Hudson River Valley, in western New York, in western Michigan, near Minneapolis, Minn., and in the Puyallup Valley of Washington, the Willamette Valley of Oregon, and the Santa Clara Valley of California.

Black raspberries are grown for commercial shipment in western New York, in western Michigan, in the districts about Wathena, Kans., and Hagerstown, Md., in the Willamette Valley of Oregon, and to a less extent in other places. There are few plantations in the Southern States or in California.

The purple varieties are grown extensively only in western New York, although for local market and home use their range is about the same as that of the blackcap.

CONDITIONS NECESSARY FOR RASPBERRY GROWING

Particular attention should be given to the locality in which the raspberry plantation is to be established.

The hot summers of the South are not favorable to production of this fruit, which is a native of cool climates. There are few plantations south of Virginia, Tennessee, and Missouri, and even the warmer parts of Virginia and Tennessee are not well adapted to raspberry growing. The black varieties are not widely grown on the Pacific coast, except in the Willamette Valley of Oregon. In most of the Great Plains area and in parts of the Mountain States, the winters are too severe or the summers too hot and dry for raspberry growing.

The raspberry plantation should be located near a good market or good shipping point if it is to be profitable. The roads to that market or shipping point should be such that the berries will not be injured when hauled over them. If the fruit is to be shipped long distances, it is essential that quick transportation and refrigerator-car service be available.

Four important factors that should be considered in the selection of a site are a soil that is well drained at all times, a soil type that allows plants to form deep roots, an ample supply of moisture, and good air drainage.

The raspberry succeeds on a wide range of soil types provided suitable moisture conditions prevail. A fine, deep sandy loam is perhaps the most desirable soil for growing raspberries, because it is managed very easily. Equally good yields of some varieties will be obtained on clay and on sandy soils if they are well managed. In general, the black raspberries seem to do best on sandy soils, but they are also grown extensively and succeed well on clay. Among the red raspberries the *Ranere* does best on sandy types of soil, but the *June* succeeds best on clay. Other varieties, such as the *Cuthbert* and *Latham*, succeed on a wide range of soil types. When the soil requirements of varieties are known, they are indicated in the characterizations given on pages 34 to 36.

Successful growth of raspberries may depend even more on the type of subsoil than on that of surface soil. Investigations have shown that subsoil types may vary considerably in some districts; because of this fact, careful examination of the subsoil has an importance that cannot be too much emphasized. The most suitable subsoil is loose enough to permit good underdrainage and yet retain considerable water. Studies made in Michigan show that a high water table or hardpan dwarfs the plants and leads to early dying out. Hardpan prevents the development of an extensive root system. A high water table causes roots to die either from lack of aeration or by making them susceptible to the attack of root diseases.

Perhaps the most important of all factors in the growing of raspberries is the moisture supply; when there is a choice, the soil that will furnish an ample supply of moisture at all times should be chosen. The water table, however, should never be within 3 feet of the surface for a very long period. Thorough drainage, as well as a full supply of moisture, is essential.

Air drainage is also an important factor. Cold air settles to lower levels, and plantations situated on land elevated above the surrounding fields will be less subject to the extreme cold of winter than those on the lower levels. Winter injury to the canes may often be avoided by choosing a site higher than the surrounding country. Furthermore, plantations on the higher elevations are not so subject to frost injury in late spring as those not so favorably located.

Free air movement during the growing season tends to lower the humidity; high humidity is very favorable to the growth of certain fungus diseases.

In the Southern States exposure is a fifth factor in the selection of a site and is of some importance. In those States a northern or north-eastern slope is preferred for the raspberry plantation, as humus and moisture are retained better on such slopes than on southern ones. For home gardens, the chickenyard is frequently a desirable place for the raspberry patch. Poultry keep down weeds, enrich the soil, and do not often injure the berries.

PREPARATION OF THE SOIL

Soil should be given the same thorough preparation for a raspberry plantation as for corn or similar crops. For the best results the plants should not be set in a field which has just been in sod; they should follow some crop, preferably a cultivated one. In many districts, especially in the Pacific Northwest, it is probably not advisable to plant black raspberries or some varieties of red raspberries after potatoes, tomatoes, or eggplants, because the fungus causing wilt of those crops is often present in the soil and may attack raspberries.

The soil in which raspberries are to be planted should be thoroughly pulverized and in the best physical condition for holding moisture. Unless the soil is rich in organic matter, manure should be applied at the rate of 8 to 10 tons per acre or a cover crop should be plowed under. It is much better to add organic matter before planting than later. Deep plowing, 6 to 8 inches or more, is necessary. Plowing may be done either in the fall or early spring. In some sections of the country fall plowing gives better results, but it should not be done if it increases the danger of soil erosion during the winter months. Thorough disk-ing and harrowing just before planting will put the soil in good condition.

OBTAINING AND HANDLING THE STOCK

Plants of the different varieties of raspberries may be obtained from any reliable nursery, and usually this is done in starting a new plantation. Good nursery plants of the different types of raspberries are shown in figure 3. It must be remembered, however, that the root systems of nursery plants of the different varieties vary greatly; a good nursery plant of one variety might be considered a poor plant of another. For example, the Potomac, a purple variety, rarely makes such a large nursery plant as does the Columbian.

It is possible to obtain a good crop of berries from plants the year after they are set and a full crop the second year. To do this, only the best grade of nursery stock should be ordered. If the plants are to be propagated at home, only the strongest tip plants of the black and purple sorts and the strongest suckers of red varieties should be selected. A good red-raspberry plant for setting should have many small roots with several inches of the old root attached.

By selecting the best tip plants, planting them in fertile soil, and giving them good care, it is possible to get more than 2,000 quarts per acre the year after setting. More than 4,000 quarts are possible the third year from either red or black raspberries. The average production of raspberries is less than 1,000 quarts per acre.

Figure 4, *A*, shows a bundle of plants of the red raspberry as it was received from the nursery. In case the plants are not to be set immediately, they should be heeled in: that is, a trench should be dug and the roots placed in it and covered with moist soil. In order to work the soil thoroughly about the roots of each plant it is necessary to open the bundles and spread the plants along the trench, as shown in figure 4, *B*. Plants should not be allowed to dry out before being planted; if they show signs of drying the roots should be wet, or if the plants are very dry, the roots should be soaked for a few hours before the plants are heeled in. Just before setting it is well to dip the roots of the plants in a puddle made of clay and water or cow manure and water. This partially protects the roots from the wind and sunlight while being planted.

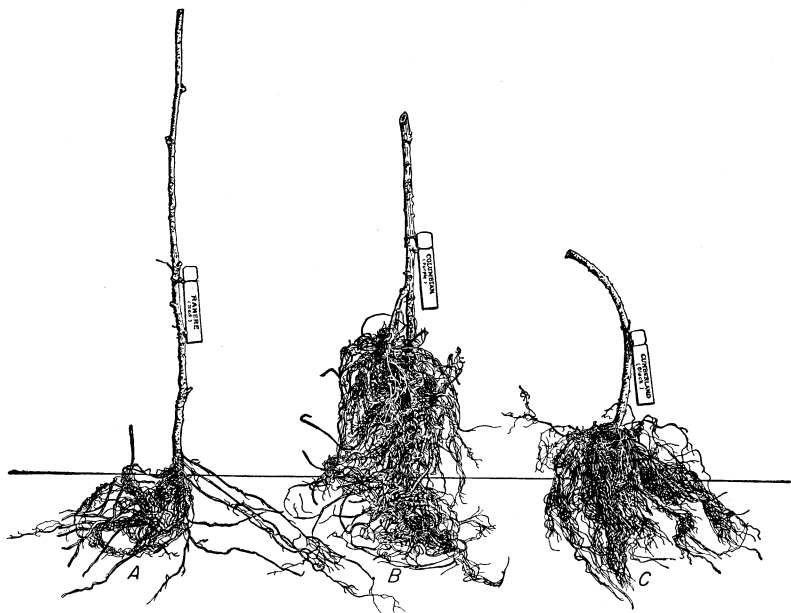


Figure 3.—Representative raspberry plants good for setting: *A*, Ranere (red); *B*, Columbian (purple); *C*, Cumberland (black).

Plants affected with crown gall should not be set. Moreover, many plants coming from fields in which the disease is present may be affected without showing it; therefore, even if only a few plants show galls when planted, many infected ones may be found later. Crown gall can be recognized by the knots and swellings which appear on the roots and about the crown. Such diseased plants are very much less productive than healthy stock, are short-lived, and are especially subject to winter injury.

Every possible precaution should be taken to prevent the introduction of virus and other serious diseases in raspberry nursery stock. Plants should be obtained only from carefully inspected and certified nurseries or plantations. Once diseases are introduced, it is hard to control them without seriously reducing the profits.

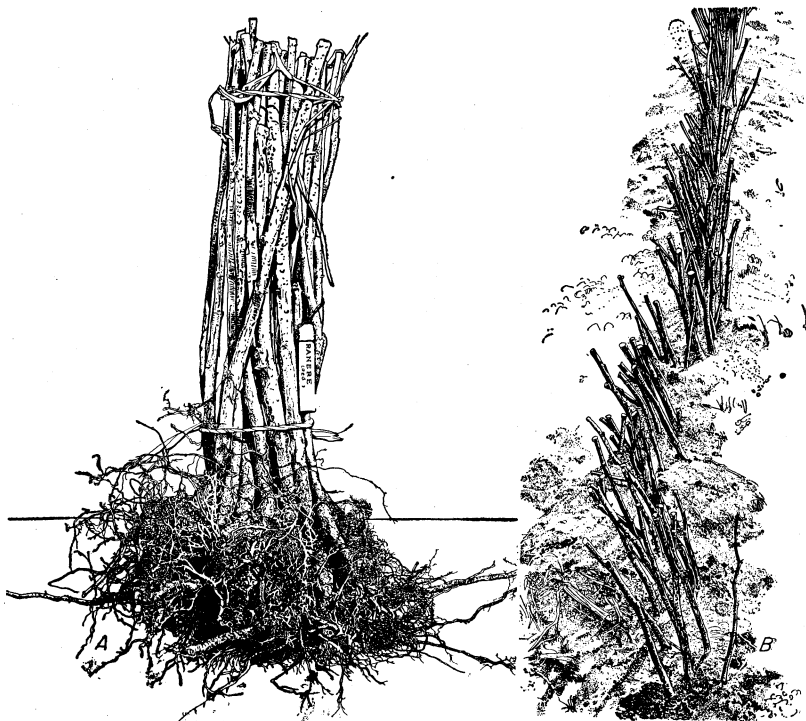


Figure 4.—A, Bundle of 27 good plants of the Ranere raspberry as received from the nursery. If such plants cannot be set immediately, they should be heeled in. B, Plants of the Cuthbert raspberry as received from the nursery heeled in awaiting favorable opportunity for being planted.

PLANTING

TIME OF PLANTING

The time of planting raspberries varies in different parts of the United States, according to local conditions. In general, the plants should be set in early spring in the eastern United States, but on the Pacific coast they should be set during the rainy season, whenever it is possible to do the work.

Spring is the best season for setting plants of the black and purple varieties, because better and more mature plants then can be obtained. Red raspberries, however, may be set in the fall with good success in districts where the winters are mild or where there is a good covering of snow to protect the plants. Plowing a furrow to fall-planted red raspberries will prevent heaving and winter injury in the Northern States. Some advantages of fall planting in districts where this is possible are the following:

There is usually a much longer period of favorable planting conditions than in the spring.

During winter the plants become thoroughly established in the soil and start growth quickly in the spring.

In the fall the leader buds from which the new canes develop are dormant and not easily broken. By spring, however, they have grown to a considerable length, often several inches, and then are very easily

broken in planting. Unless the roots are vigorous, such plants may not develop new shoots. Figure 5, *A*, shows the leader buds at the base of the cane in a dormant condition and figure 5, *B*, the shoots from these buds after they are several inches long.

In some districts, especially in the Pacific Northwest and in New Jersey, plantations of red raspberries are commonly started with so-called green plants. A month or 6 weeks after growth begins in spring the young green plants, or suckers, are transplanted during or after a period of rain. If the season is favorable, this practice may prove satisfactory and often the best growth is obtained. If, however, a drought occurs soon after transplanting, the young plants will suffer severely. This practice is recommended only for districts where the climate is favorable.

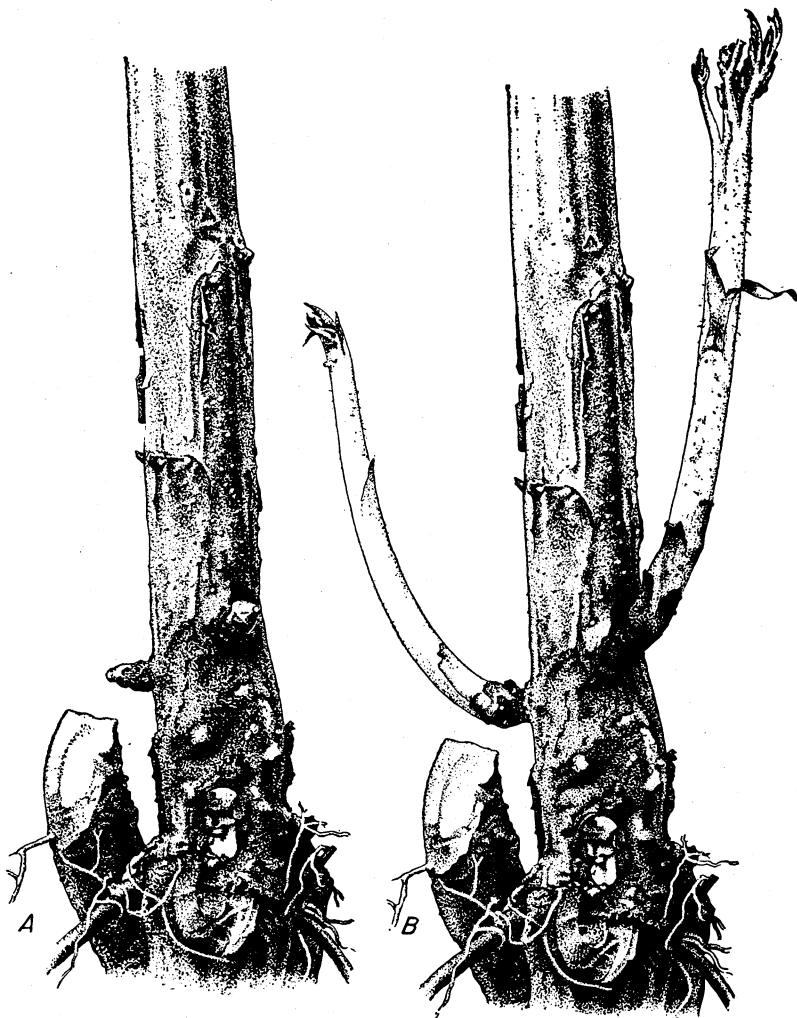


Figure 5.—Lower part of a raspberry cane showing (*A*) on February 9 dormant leader buds from which strong vigorous shoots will grow in early summer and (*B*) on March 7 the new shoots that have started from these leader buds.



Figure 6.—Red raspberries 1 year old planted in accordance with the hill system. (Photographed at Milton, N. Y., June 18.)

PLANTING DISTANCES UNDER VARIOUS SYSTEMS

Three systems of culture are used in growing raspberries—the hill, the linear, and the hedge system. The term “hill system” is restricted to that method of tillage in which cultivation is possible on four sides of each plant. When the cultivator is run in only one direction and only the plants originally set are allowed to fruit, the term “linear system” is used. If some of the suckers which come from the roots of red raspberries are left to form a solid row and the cultivator is run in one direction only, the term “hedge system” is employed.

The distance between the rows in each system should be determined by the fertility, moisture supply, and type of soil and by economy in the cost of cultivation and in the use of land. Where the land available for planting is not limited it is usually desirable to make the rows far enough apart to allow the use of two-horse- or tractor-drawn implements in cultivation. Where the available land is limited, the rows may be placed closer together and one-horse cultivators or garden tractors used.

Under the hill system of culture the plants are usually set about 5 feet apart each way, but the distance apart may range from 3 by 6 to 8 by 8 feet. The usual distance, 5 by 5 feet, however, allows the use of only one-horse cultivators or garden tractors. Figures 6 and 7 show raspberries planted according to the hill system. This system is used to some extent in New York, northern Michigan, and Minnesota in raising red raspberries and in Maryland in raising black varieties. It is adapted only to localities where varieties that produce comparatively few canes are raised. It has the advantage of requiring less hand work in keeping out grass and weeds, as the cultivator can be run in both directions; also the berries can be more easily picked under this system.

If the hedge or the linear system is used, the horse cultivator can be run in one direction only and more hand-hoeing is necessary. Under these systems the red varieties usually should be set $1\frac{1}{2}$ to 3 feet apart in rows 6 to 10 feet apart. In the eastern United States the most common and desirable distance between the rows is 7 to 8 feet. If two horses are to be used in cultivating, the rows must be at least 8 feet apart. In the Pacific Northwest, where the canes grow very tall, the planting distance for red raspberries is usually $2\frac{1}{2}$ to 3 feet by 7 to 10 feet. In parts of Colorado and other States where irrigation



Figure 7.—Red raspberries planted in accordance with the hill system. The plant at the left center has seven bearing canes, which are tied to a single stake. (Photographed at Milton, N. Y., June 18.)

and winter protection are necessary, the plants are usually set in rows 7 feet apart.

Black raspberries, which are nearly always grown under the linear system, should be planted 3 or 4 feet apart in rows 7 or 8 feet apart. In Oregon the 8- by 8-foot spacing distance is rather common where cultivation is in two directions. Where it is in but one direction, plants may be set 4 to 6 feet apart in rows 8 to 10 feet apart.

The purple varieties also are grown under the linear system and should be planted 4 or 5 feet apart in rows 7 or 8 feet apart. The Columbian and other purple varieties of equal vigor should be at least 5 feet apart in the row, but the Potomac may be set 4 feet apart.



Figure 8.—A, Placing a raspberry plant in a hole made by pushing a shovel into the soil and forcing it forward. B, Firming the soil around the roots after withdrawal of the tool. In this field only 2 or 3 of 10,000 plants set failed to grow. (Photographed at Putney, Vt., April 23.)

If the plants are checked in both directions when set in accordance with either the hedge or the linear system and are 3 or 4 feet apart in the row, it is possible to run a one-horse cultivator both ways for the first year. This will save much work and reduce the first year's expense.

SETTING THE PLANTS

Before planting, the tops of plants of all types should be cut back to a height of 6 inches or less. To make it easy to handle the plants and to indicate the rows after setting, 4 to 6 inches of the cane is often left; but if 12 to 24 inches of cane is left new shoots may not start and the plants may die. To help control anthracnose on black and purple sorts, it is recommended that all the cane be removed or entirely buried when the plants are set. By this means infection from old canes can be eliminated at planting time. If a garden patch is

being planted, it is better to cut the canes back to within a few inches of the leader buds.

The plants should be set slightly deeper than they formerly grew. Sometimes in lighter soils it is well to set red raspberries as much as 3 inches deeper than they grew, in order to protect them from drought. Black and purple raspberry plants should be set not more than an inch or two deeper than they originally stood to avoid danger of smothering the tips.

Figure 8 illustrates a common and inexpensive method of setting the plants. The rows have been marked out previously, and plants have been dropped every 3 feet along the row. A shovel or spade is thrust into the ground, the handle is pushed forward, and the root is placed in the space thus opened, as shown in figure 8, *A*. The tool is then withdrawn and the earth is firmed about the roots, as shown in figure 8, *B*. Plants should not be dropped much ahead of those who are setting them, however, as exposure to the sunlight and wind dries and kills the roots.

CULTIVATION

MAINTENANCE OF MOISTURE SUPPLY

From the time raspberry plants are set, they need an ample supply of moisture because they are affected more quickly and seriously when it is deficient than are most other fruit plants. Tests have indicated that the black raspberry loses moisture through its leaves more than twice as fast as the average plant that has been studied. The natural habitat of brambles is in partial shade where resistance to heavy evaporation is not necessary, because of protection from taller vegetation. Man has greatly modified these natural conditions by moving brambles into open fields. This fact probably explains winter or spring injury to brambles. Full sunlight starts them growing too early and they suffer from drought injury.

Yields of raspberries range from 7,000 quarts an acre in some sections to an average of less than 1,000 quarts an acre for the whole country; this range is largely due to differences in the moisture supply in the various sections. In the sections where the yields are highest, a deep soil furnishes a uniform and ample supply of moisture at all times. To get the best results, therefore, the grower should maintain a uniform and ample moisture content in his soil by tillage and by supplying humus not only during the growing and ripening of the fruit but also during development of the canes. Some growers make it a regular practice each year to mulch their fields to a depth of several inches with straw, leaves, or green hay. The cost of this practice is heavy, but the moisture supply is well retained and the soil temperature is much more uniform. In a test in Maryland where the plants were not growing well the mulched plants gave a yield five times that of the unmulched ones.

In semiarid and arid sections where irrigation is practiced, the fruiting season is longer than in most humid or nonirrigated sections. The use of irrigation in the Eastern States also has extended the picking season and made the plants thriftier. Larger yields of fruit of the Ranere raspberry in the summer and fall have followed irrigation of that variety.

In the semiarid and arid sections of the Pacific coast, irrigation should begin almost as soon after the rainy season as is necessary for

garden crops and should be continued at least until after the picking season is over. The frequency of irrigation will depend upon the local climate, the soil type, and the management of the soil. In southern California the plantation should be irrigated as often as every week during the fruiting season and about once in 2 or 3 weeks during the rest of the dry season. If cultivation follows each application of water, the irrigation need not be so frequent and the soil will be kept in better condition than without such tillage. In Southern California under such treatment, the Surprise red raspberry will not only produce a good second crop of fruit during the late summer or early fall but will also produce some fruit almost continuously from the first picking in the spring until late fall. In arid and semi-arid sections other than California such frequent irrigation is not often used; its frequency is determined by local conditions.

In the humid sections of the Eastern States irrigation should be practiced chiefly or entirely during the growth and ripening of the fruit; it will pay only when an ample moisture supply cannot be maintained by tillage. Since the raspberry ripens its crop during the summer when droughts are likely to occur, some growers have found irrigation profitable. In one test in Michigan an increased yield of about 1,000 quarts per acre was obtained by irrigation during a dry season.

INTERCROPPING

In order to reduce the cost of intensive cultivation of a raspberry plantation during the first year after setting, other crops that need cultivation during the spring and early-summer months may be grown between the rows. Among the crops best suited to this purpose are the tomato, cabbage, cauliflower, bean, pea, summer squash, and potato. Potatoes and tomatoes, however, should not be grown with black varieties or with those red varieties subject to wilt (western bluestem). Grain crops should not be used, as they are not cultivated and will take moisture and plant food needed by the raspberry plants. In the second season no other crops should be grown, as the raspberry roots should occupy all the ground.

TILLAGE

Tillage in raspberry fields must be thorough and more regular than for most other crops. If grass and weeds get a start, it is very difficult and costly to clean the rows; furthermore, they take up the needed moisture and interfere with the development of new canes. If grass is allowed to make a sod in a field trained to the wide-hedge system, it is usually cheaper to set out a new field than to clean out the sod. Plowing in early spring is a common practice with many of the best growers. At the centers between the rows it may be 6 to 8 inches deep, but it should be only 3 to 4 inches deep next to the plants. In the Pacific Northwest disking has replaced plowing to a great extent because too many roots are cut by the plow.

Except in rainy weather a cultivator or harrow should be used frequently up to picking time. Some growers consider it profitable to use it as often as once each week, and this is sometimes necessary for weed control. The cultivation should stir the soil to a depth of 2 to 3 inches only, as part of the raspberry roots are shallow. Deep tillage may cause serious injury unless it has been practiced

from the time the plantation was set. Many growers shorten the cultivator or harrow teeth which run next to the plants in order to disturb as little as possible the young feeding roots near the surface.

During the harvesting season the berries need an additional supply of moisture, and ordinarily the cultivation should be continued. Many growers cultivate after each picking, loosening the soil packed down by the pickers. If too much dust is carried to the fruit it may be necessary to cultivate only occasionally during the picking season. Also if no trellis or stakes are used and if the canes bend over under a crop of fruit, it will be impossible to use a cultivator without knocking off too much fruit.

Later tillage is for the purpose of keeping down weeds and grasses. Fall tillage, however, tends to stimulate the development of new growth, which is tender and somewhat more subject to winter injury than the older growth. Fall tillage, therefore, should be avoided as much as possible where winters are severe.

SUMMER THINNING

In the red-raspberry districts of western Washington most of the best growers thin the new canes in early summer when the second hoeing is done. At that time a large part of the surplus canes are easily removed before they have grown large. This practice conserves the plant vigor and makes picking easier. Additional canes are often removed just before picking. Black-raspberry canes are not often thinned at that time because of the cost; however, a few expert growers in Oregon thin the new canes before the picking season.

MAINTENANCE OF FERTILITY

The use of fertilizers in raspberry plantations is governed by the same principles that apply to their use with other fruits. As soils vary in the quantity and availability of the plant food they contain, the fertilizer problem is a local one which each grower must solve for himself. By using varying amounts of the different elements of plant food on different plots and keeping a record of the yields, each grower can determine readily what kinds and quantities of fertilizer to apply.

Good management, however, will insure a large amount of humus in the soil at all times. It is especially desirable that the humus supply be ample when the plantation is first set out. It is much easier and cheaper to furnish the humus by means of cover crops and stable manure before the plantation is set than afterward when the plants are growing. Moreover, by such extra care before setting it is possible to get a fair crop of fruit the second season. Because it costs so much to care for a plantation for a year it will pay well to have the soil in a high state of fertility before the plants are set, so that the plantation may be brought into bearing a year sooner than would be possible otherwise. Whenever possible, barnyard manure should be used before a plantation is set. If manure is not available, one or two cover crops should be plowed under. Many western growers now seed oats or barley with vetch and allow them to mature and reseed. Then the thick new growth is plowed under before raspberries are planted.

A distinction in the fertility requirements of red and black varieties should be made. Apparently, no soil is too fertile for satisfactory results with the black raspberry—the richer the soil the stronger the growth and the greater the crop. The red raspberry should be grown on a fertile soil, but the relation of fertilizers to crop production in red varieties is not well understood. In the Pacific Northwest fertile river-bottom soils are among the most productive; the yields obtained by growers using good cultural practices, however, vary from 1 to 6 tons of berries per acre. Apparently these variations in results are chiefly due to the differences in fertility and moisture supply of the soil.

Studies made in Michigan showed that the canes with greatest diameters were much more productive than those with smaller diameters. Furthermore, red-raspberry canes so vigorous that they branched, produced much more fruit than the unbranched ones. Though the best results may not come from using as heavy applications of fertilizer for the red as for the black raspberry, the best yields of red raspberries in the United States are from fields where annual applications of 2 to 15 tons per acre of stable manure and 400 to 500 pounds of fertilizer are made. Purple varieties seem to respond somewhat as do the black raspberries.

In many sections no fertilizers are used on bearing plantations. In the older raspberry sections, however, some commercial fertilizer and stable manure are used, and it is considered profitable to apply them. Stable manure, however, usually has given the best results and experiments have shown that it furnishes the best means of enriching the soils on which the experiments have been tried. It not only furnishes plant food but supplies large quantities of humus. If an annual application of about 10 tons per acre is made, the humus supply should be maintained and with proper treatment in other ways the field should be kept in a high state of productiveness. Some soils and some sections will need more than 10 tons per acre and others less. A heavier application should not be made unless it has been found by actual trial to be desirable, as it is possible to stimulate the growth of canes and leaves to such an extent as to reduce productiveness.

Experiments indicate that the average composition of stable manure is low in phosphorus and a little low in nitrogen. It is therefore suggested that growers try the addition of 100 pounds of nitrate of soda and 400 pounds of superphosphate per acre in addition to 10 tons of stable manure. Poultry manure is richer in nitrogen, and growers have had good results from light applications of strawy litter.

If stable manure is not available, an application of about 200 pounds of nitrate of soda per acre to black-raspberry fields at blossoming time is suggested for the Eastern States.

Cover crops may be used to maintain the humus supply. Oats seeded at the rate of 3 bushels per acre in late summer should give a dense stand of material to turn under before winter, or they may be left to serve as a covering during winter and plowed under in the spring. Cowpeas, millet, vetch, various clovers, and other crops may also be used as cover crops. Care must be taken in sowing winter oats, vetch, and clovers, as they live through the winter in many sections. If they are drilled between the rows of raspberries and turned under before they become too rank in the spring, little trouble should

be experienced. Disks are now used in the Pacific Northwest to work cover crops into the soil. Such crops should be disked down before they begin to compete with the raspberry plants for moisture.

TRAINING AND PRUNING

CHOICE OF SYSTEM OF TRAINING AND PRUNING

The best system of training and pruning different types of raspberries depends largely upon their manner of growth. All types send up shoots from the leader buds, which usually are formed at the base of the old canes, as shown in figure 5. Sometimes only 1 such bud is produced on each cane, but usually at least 2 are formed, and sometimes 3 or more appear. Thus, if 2 canes grew the first year after planting and each produced 2 buds, 4 canes would be formed the second year, 8 the third year, and 16 by the fourth year. However, some of the buds do not start and many of those that do start make weak canes; therefore, about the same number of strong canes are produced the first year after the plantation comes into full bearing as during each of the following years.

The new shoots of all types of raspberries complete their development in size the first season. During the second season small side branches are sent out and on these the fruit is borne. Soon after the berries ripen the cane dies. Thus the canes are biennial—that is, they live for part of 2 years; the roots are perennial, living for many years. A few varieties of red raspberries, among which is the *Ranere*, bear fruit on the tips of the new canes in the summer and fall of their first year of growth. Such tips die back, and the parts of the cane which have not fruited bear the following summer.

In addition to producing canes from the leader buds, red raspberries send up shoots called suckers from their roots (fig. 9), but the black and purple varieties do not send up suckers. Some varieties of red raspberries produce suckers in large numbers; others produce few. Deep plowing or cultivating may cut the roots of the red raspberry and cause an increase in the production of suckers. Therefore, if some system of training were not used a red-raspberry field would soon become a dense thicket of canes, each competing with others for food, moisture, and light, and the berries could be picked only with difficulty. Because the methods of pruning and training red raspberries differ from those used with the black and purple types, they are described separately.

The system of training and pruning varies not only with the type of raspberry but also with the vigor and nature of the variety, with climatic conditions, with the cost of materials, and with the preference of the grower. Thus, the *Ranere* red raspberry produces numerous comparatively slender canes, whereas others, like the *Latham* and *Chief*, make fewer canes, which are much stouter and more erect. The *Ranere* is not a tall-growing variety, but the *Cuthbert* and *Washington* canes grow very tall. Varieties of the black and purple types do not show such great differences in growth as do the red sorts; nevertheless the training and pruning system to be used with these types also will depend to a large extent upon the habit of the variety.

Reference to the figures illustrating the principal methods will indicate how different is the growth of plants in various sections and



Figure 9.—A red-raspberry plant having two strong canes which grew from leader buds and a large number of suckers springing from the roots.

how numerous are the systems of training. Many variations and modifications of each system are used, but only the principal ones will be described.

TIME OF PRUNING

All the old canes of red, black, and purple raspberries should be cut out immediately after they fruit. By doing this diseases on the canes and leaves are removed, moisture that might be lost through the leaves is conserved, and the new shoots get more room and light. Cutting out the canes late in the summer or fall is not advisable, because the new shoots may not harden sufficiently to withstand winter cold and may break over with heavy snows. If the young shoots of black and purple raspberries are to be pinched back to in-

duce branching, this should be done early in summer when the shoots are 12 to 36 inches high, as discussed on page 25. All additional pruning should be done in early spring while the plant is still dormant but after danger of cold injury has passed.

TRAINING RED RASPBERRIES

As indicated in a previous section, three methods of culture of red raspberries are in use—the hill, the linear, and the hedge system. As the planting plan of each is different, the system to be used must be determined before the plantation is set.

The Hill System

Under the hill system a stake $1\frac{1}{2}$ to 4 inches in diameter should be driven into the ground beside each plant when it is 1 year old; the canes should be tied twice to each stake, once about half way up, and again at the top of the stalk. About seven of the strongest canes, more if the canes are of a large diameter, should be left to each plant and the others should be cut out. Under eastern conditions when as few as five canes are left the yields may be distinctly less than when eight canes are left. Ordinarily the tips are not pruned back. In Minnesota, however, the canes are topped at about 5 feet. Figures 6 and 7 show examples of tall-growing red raspberries grown under this system. The stakes in this case extend about 6 feet above the ground. Other varieties have shorter canes, and the stakes should correspond to the height of the canes. Varieties like the Latham may be grown under this system more easily than those like the Ranere which make a rank growth of suckers.

The hill system is used in New York and Minnesota extensively and is recommended for sections having similar conditions. Slightly greater yields under the hedge and linear systems may be more than offset by the lower tillage costs and the ease of harvesting under the hill system. To gain the advantage of this system, however, it should be possible to cultivate in both directions with comparative ease, and it should also be possible to obtain stakes at a reasonable cost.



Figure 10.—Red raspberries at Putney, Vt., planted in accordance with the hedge system and mulched with straw. The rows are too wide for the best results.



Figure 11.—Field of Cuthbert red raspberries planted in accordance with the hedge system. The canes are pruned back in the spring, so that they will support the crop of fruit. (Photographed in July.)

The Hedge System

Where the canes are stout and 3 to 5 feet tall, growers in the Eastern States often allow a solid row or hedge 2 to 3 feet wide to form, as shown in figure 10. This system is the most common one in the eastern United States and is adapted to such short-caned varieties as the Sun-



Figure 12.—Field of red raspberries planted in accordance with the hedge system. The canes are held erect by a two-wire horizontal trellis. Note the irrigation ditches. (Photographed at Loveland, Colo., July 22.)



Figure 13.—A wooden support used in raspberry fields where two wires hold the bearing and young canes upright. A bent nail keeps the wires from slipping below the desired height.

rise and Latham. A modification of the hedge system is used in New Jersey in growing the Ranere. The canes of the Ranere are comparatively slender, and in early spring growers cut the tops back with hedge shears so that they can support the crop in an erect position. Sometimes the Cuthbert also is grown under this system, as shown in figure 11.

The hedge system is modified further in some sections where the canes grow taller or are not stout enough to hold the fruit in an erect position. Under such conditions a horizontal trellis is made

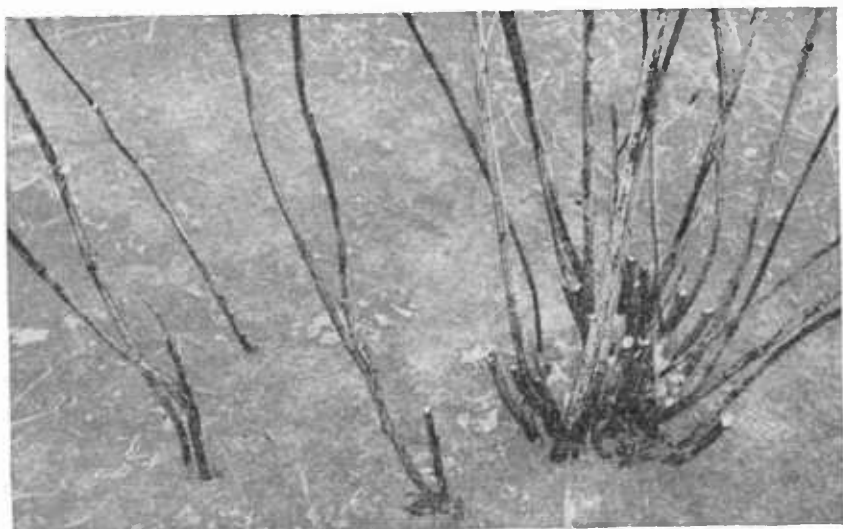


Figure 14.—Red raspberries planted in accordance with the narrow-hedge system; the canes are kept in a row about 12 inches wide and are well spaced in the row.

when the plantation is 1 year old by stringing two wires along each end of crosspieces attached to posts set every 15 to 30 feet in the rows. The wires support the canes, so that they are not broken by pickers or in cultivating. Usually no pruning back is done; however, tests in Michigan showed that a light heading back of the Cuthbert variety in the spring resulted in increased yields and easier picking. Severe heading back decreased yields and made harvesting more difficult.

The hedge system is used somewhat in New York, in California, and in other States. A slight modification of it is used in the irrigated districts of eastern Colorado, where the canes are buried in winter for protection against the cold. In this section posts are set only at the ends of the rows, as illustrated in figure 12. The wires which hold the canes erect are held in place by wooden supports (fig. 13) which hold the wires about 2 feet high and $1\frac{1}{2}$ feet apart and can be taken down at any time, so that the wires will drop to the ground and thus be out of the way.

This system, called the wide-hedge system, has serious disadvantages. When the row is 2 to 3 feet wide it is difficult to get the berries picked; there always are some weak canes which bend over so that the fruit becomes dirty; there is such competition between the canes for moisture and light that the fruit is smaller than it otherwise would be; and unless the rows are separated more than 8 feet a two-horse cultivator cannot be used. Perhaps the most serious disadvantage of this system is that it is very difficult and expensive to keep fields in which it is used free from grass and weeds.

For most sections the best form of the hedge system is that called the narrow-hedge system, shown in figure 14. Suckers are allowed to grow up only in the rows between the plants originally set, and all others are kept out. The rows then will be about 12 inches wide, and a large part of the tillage can be done with a cultivator. Wire trellises are used with this, as with the wide-hedge system, when the canes are very tall or very weak. Light heading back in the spring

should be done. Studies in Michigan showed that 10 canes per 4 lineal feet of row of one variety gave greater yields than where greater thinning was practiced.

For much of the eastern United States this narrow-hedge system is one of the most desirable; it should be adopted by growers in place of the wide-hedge system unless the hill or the linear system can be used.

The Linear System

The linear system, which differs from the hedge system in that no suckers are allowed to grow, is becoming more popular and is to be preferred to any other in some sections. It is used very commonly in all parts of the United States in training varieties which have strong, erect canes, and it is the only system used to any extent in Oregon and Washington. The simplest form of this system is that used where the canes are stout and short and will hold an erect position when bearing a full crop of fruit. All sucker plants should be removed and the plants originally set kept for fruit bearing. Most of the cultivating can be done with the horse cultivator and horse hoe, and comparatively little hand work is necessary. When grown under this system the tall-caned varieties are headed back somewhat until the canes are self-supporting.

In Oregon and Washington, where the tall-caned Cuthbert and Washington are grown and where the canes of many of the other varieties grow very tall, some means of supporting the canes is used. The two most common practices are shown in figure 15. There is little



Figure 15.—Field of Cuthbert raspberries planted in accordance with the linear system. Note at the left that two wires, one on each side, hold the canes erect. The wires are about 5 feet above the ground, and the canes are topped about $5\frac{1}{2}$ feet above the ground; in general topping at $5\frac{1}{2}$ feet has been found best where the canes grow tall. Note at the right that the canes are woven to one wire, but the canes average about $6\frac{1}{2}$ feet in height. (Photographed at Sumner, Wash., February 20.)

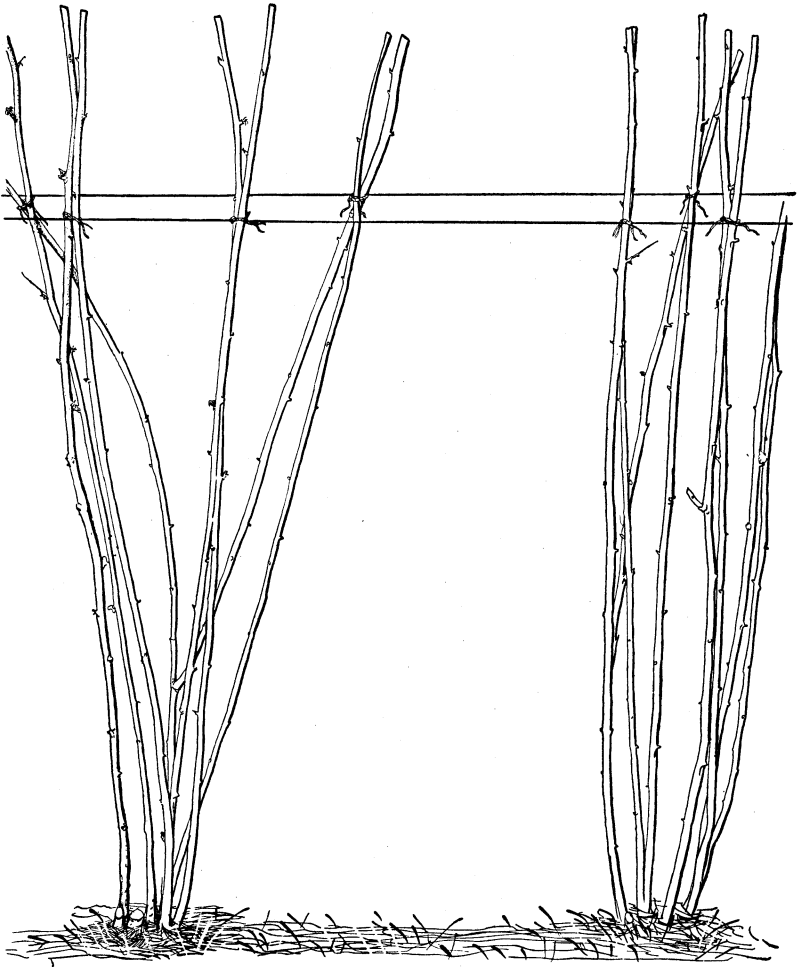


Figure 16.—Cuthbert raspberries planted in accordance with the linear system. Note that the fruiting canes are tied to wires about 5 feet high on each side and that the young canes grow up between the fruiting canes. Topping should be at 5½ feet, as shown, in order to bring the fruit within reach.

difference in time required to train the canes by either system. To the left are shown canes that were pruned or topped to a height of about 5½ feet and are held erect by a horizontal two-wire trellis, such as is used in the hedge system. Two wires about 5 feet above the ground, one on each side of the row, hold the canes erect. To make picking more convenient and to prevent injury to the buds by wind whipping the canes are often tied to the wires on each side, and the new canes are allowed to grow up between the wires, as illustrated in figure 16. Thus the fruiting canes are separated from the new ones.

Often a third wire is placed a little above the two horizontal wires, and all the canes are tied to it. Figure 17 shows a simple method of tying each cane separately with one string. A hard knot should be made every few feet, so that if the string breaks the damage will not

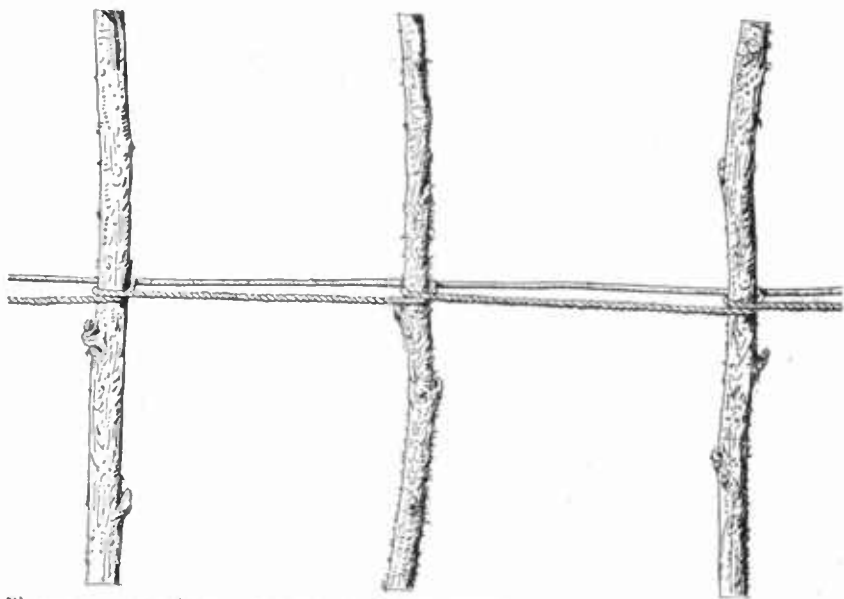


Figure 17.—Raspberry canes tied to a wire trellis. Canes can be tied very rapidly when this system is used, and the cost per acre is small.

be extensive. Where some provision is needed to keep the new canes out of the way of pickers and cultivators, one or two additional wires are string along just before picking. Some growers in the Eastern



Figure 18.—Field of 1-year-old red raspberries trained to single-wire trellises in accordance with the linear system. The bearing canes are tied to the wire to hold them erect. (Photographed at Marlboro, N. Y., June 23.)

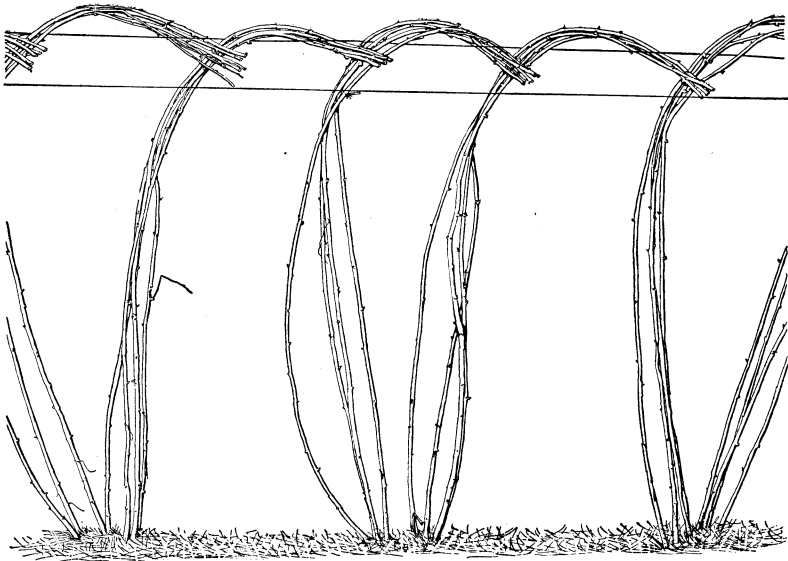


Figure 19.—Red raspberries planted in accordance with the linear system and trained to a wire trellis. The canes are arched over a single wire and caught under the canes of the next hill. Half of the canes of each hill are woven separately to spread them apart. The projecting ends are cut off. Two additional wires are used to hold the new canes erect.

States use another form of wire trellis; all the fruiting canes are tied to a single wire, as in figure 18, or when very tall, to two wires, one above the other, to hold them erect. The tying is inexpensive and is easily done.

Though topping at 5½ feet and tying to wires is a common practice in the Northwest and some of the highest yields have thus been obtained, a second system of training is also used, but less commonly than formerly. Under this method, as shown at the right in figure 15, the canes are arched over a single wire and caught under those of the next hill. The ends are then woven along the wire and among the canes or are topped as shown in figure 19 at a length of about 6½ feet. In order to distribute the fruiting space more uniformly it is better to weave each cane separately or not more than four canes at a time than to weave all the canes of a hill together. Under this system one or two additional wires are also used to hold the young canes erect.

Where the canes do not grow so tall as those shown they may be topped at a height of 4 or 5 feet and the trellis built lower. Topping is usually done in the spring just before growth starts.

Many modifications of the systems described are in use and are adapted to particular conditions. The linear system where only the original plants are kept for fruiting or the narrow-hedge system where the original plants and a very few suckers well distributed between them are retained are generally the best. The life of the plantation under these systems is much longer, it is easier to conserve moisture in times of drought, and the picking is easier than in plantations trained to the wide-hedge system.

TRAINING BLACK AND PURPLE RASPBERRIES

Black and purple raspberries are nearly always planted on the linear system. As they do not send up suckers from their roots, their training is much simpler than that of red raspberries. The young canes should be topped in order to enable them to stand erect when bearing a heavy crop of fruit. Black raspberries should be topped at a height of 12 to 30 inches, depending on their vigor, 18 inches being the most common height. Purple raspberries should be topped at a height of 30 to 36 inches, as their growth is more vigorous. Topping may consist in cutting off the ends of the canes after all have reached the desired height, usually just before picking time.

Topping also may be done by pinching off with the fingers the ends of the young canes as soon as they reach the proper height. In this case it will be necessary to go over the plantation several times, as the new canes do not all reach this height at the same time. Pinching the tips is preferable to cutting the ends wherever disease-producing organisms are likely to enter the cuts and kill back the canes.

Side branches, called laterals, grow from the buds along the cane which has been pinched or pruned back. These laterals grow to a length of several feet by late summer. The next spring, before growth starts, they should be shortened according to the vigor of the plant and the habit of the variety. The fruit is borne on the growth of the current season, which starts from the well-developed buds on the laterals, and the number and size of the berries can be controlled by the number of buds left on them in the pruning. Varieties differ in the location of the buds and should be pruned accordingly. On some varieties the buds start very near the base of the lateral, next to the main stem, and on others at a distance from the base. In the



Figure 20.—Purple raspberries planted in accordance with the linear system. By careful pruning each plant is made to support its crop of fruit. The canes were topped 2 feet high and the laterals were pruned back to 18 or 20 inches. (Photographed at Webster, N. Y., July 15.)

former case the laterals should be pruned shorter than if the buds are borne at a distance from the base.

Investigations in Michigan showed that where the canes are small the laterals should have not more than 2 buds each, whereas the largest canes can carry as many as 8 to 12 buds to each lateral. If more buds are left on each lateral, more berries will mature; but they will be smaller and of poorer market grade than if only 2 to 6 buds had been left. Moreover, the total crop from those with the small number of buds per lateral will be equal to or greater than that from plants with the longer laterals. The cost of picking will be less and the berries will be of higher grade than those from bushes with the greater number of buds to the lateral. In the Eastern States canes

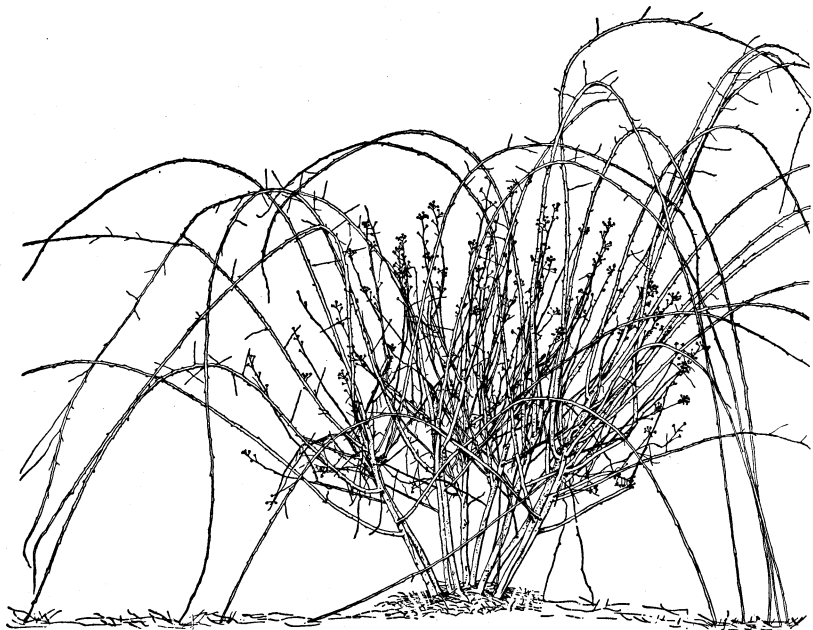


Figure 21.—A black-raspberry plant before removal of old canes, thinning, or pruning, showing laterals rooting at the tip. (See fig. 22.)

pruned in this manner are not ordinarily supported. In Oregon a 2-wire trellis about 3 feet high is sometimes used to support the canes, and occasionally the canes are tied loosely together for support instead of to wires. Rarely they are tied to stakes set by each plant. Figure 20 shows a field of purple raspberries with laterals pruned back to 18 or 20 inches, and figures 21 and 22 illustrate the method of pruning both black and purple types.

Occasionally the canes of black raspberries are topped at a height of $3\frac{1}{2}$ to 4 feet and a one-wire trellis or a horizontal trellis with a wire on each side of the row is used to hold the canes erect. In some few cases they are not topped but are trained to trellises as described for training red raspberries. Rarely, however, are the purple varieties trained under any system other than that which includes topping at a height of $2\frac{1}{2}$ to 3 feet and pruning back the laterals in the

spring. The expense of such a system is less than when a trellis is used; under ordinary conditions the maximum yield of fruit of both black and purple raspberries will be obtained from this system at a minimum cost.

REMOVING OLD CANES AND THINNING NEW ONES

In the Eastern States the old canes are often removed as soon as the crop is harvested. In Oregon and Washington they are usually not cut out until the beginning of cold weather and sometimes not until early spring.

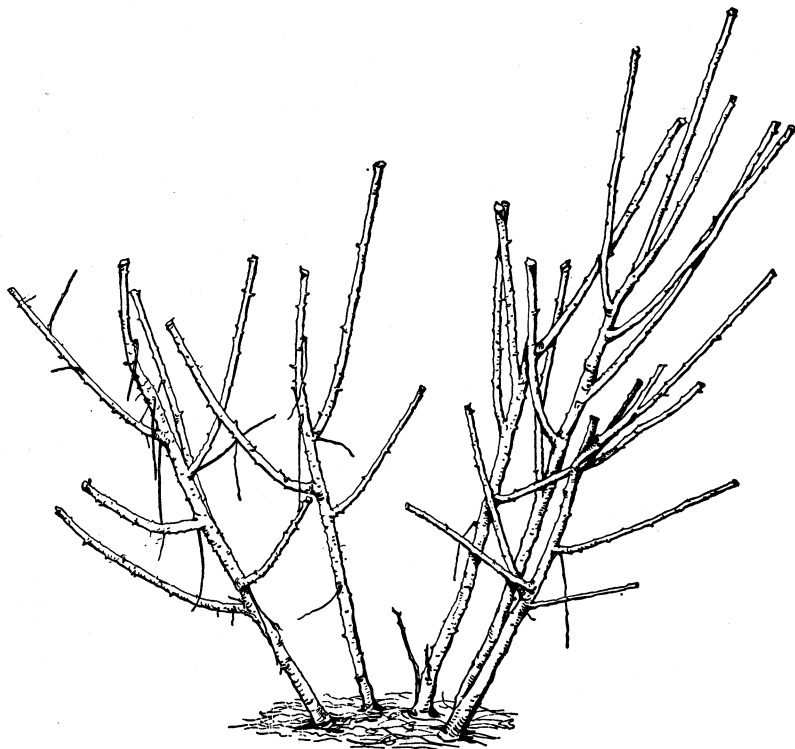


Figure 22.—The black-raspberry plant shown in figure 21 after removal of the old canes and pruning, leaving each lateral branch 6 to 8 inches long. Such plants, where the canes are more than one-half inch in diameter and the laterals are pruned back heavily, bear maximum crops of large berries.

At the same time that the old canes are cut out the young canes and suckers should be thinned. When red raspberries are grown in hills, all suckers and all weak new shoots should be removed. Ordinarily about 7 strong, vigorous canes should be left, but in vigorous hills when the plants are set 5 feet apart each way 8 or 9 canes may be safely left. In New Jersey as many as 10 to 12 may be left in each hill of the Ranere, which makes a large number of small canes. Sometimes, in order to obtain a large crop on the new canes of the Ranere in late summer, all canes are cut off at the ground in early spring,

and the strength that would be required to mature an early crop is forced into cane production.

Investigations in Michigan indicated that in order to get maximum crops all the strong canes (over one-half inch in diameter) of the black and purple raspberries should be left. Most plants of black varieties average 4 or 5 strong canes each, though fields with an average of more than 15 canes over one-half inch in diameter have been seen. Strong plants can support all the canes over one-half inch in diameter if the laterals are closely pruned; weak plants may not be capable of carrying more than 2 canes.

When the hedge system is used with the red varieties the canes should be thinned so that they are not closer together than 8 inches. When several canes appear from the same crown, the more vigorous ones should be left. Figure 14 shows proper thinning under this system. Figures 15, 16, and 19 show red-raspberry plants under the linear system in which the canes have been thinned properly, and figures 6, 7, and 23 show red raspberries under the hill system with canes thinned correctly.

Different types of cutters sometimes used for removing the old canes of black raspberries are shown in figure 24. When the blade is kept

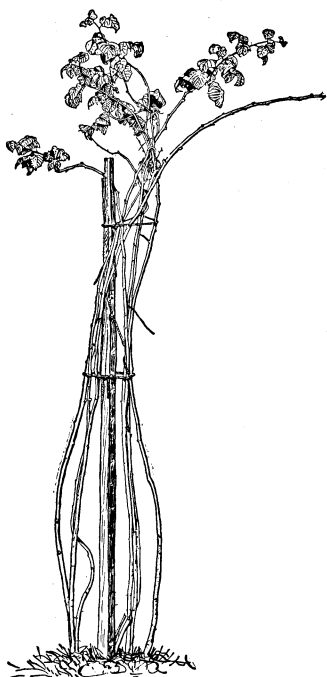


Figure 23.—Red-raspberry plants grown in accordance with the hill system, the canes being trained to stakes. Seven canes have been left for fruiting.

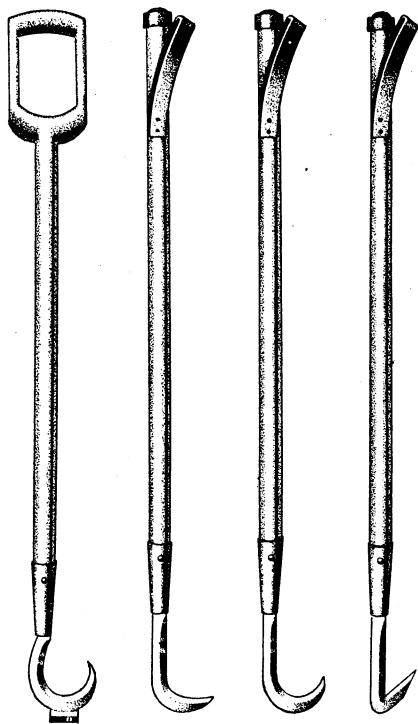


Figure 24.—Home-made cutters used to cut out old canes of black raspberries and superfluous new ones. The total length of the cutters is about 34 inches. Straps on the handles of those at the right enable the worker to maintain a firm grip.

sharp and a quick pull is given in cutting, such a tool is very satisfactory. Pruning shears of various types are most often used in cutting out old canes and in pruning red raspberries. In New Jersey, where the *Ranere* is grown extensively, hedge shears are used to cut off the ends of the young canes which have fruited and to prune the canes back to the proper height.

PRUNING FOR LATE FRUIT

In order to extend the season of red raspberries for the home table, the canes may be cut back to within about a foot of the ground in the fall or in early spring. The strength of the plant then will go into the lower buds and a long shoot will be made before the flowers appear. The fruiting season may be extended 2 to 4 weeks by this practice, but the crop will be reduced considerably.

WINTER PROTECTION

Experiments in Missouri indicated that removal of the first shoots that appear in the spring result in the growth of later canes that are much hardier. This practice has been used commercially in Connecticut for many years. In other experiments in Missouri a late-summer cover crop of oats (3 bushels per acre) with an early-fall application of nitrate of soda (225 pounds per acre) resulted in greater hardiness. How widely this practice will prove effective is not known.

In many parts of Colorado and in some of the western North Central States raspberry canes must be protected from the cold, drying winds of winter. Usually soil is used for this purpose and is more satisfactory than straw or similar material. The canes are all bent over in the same direction and held down by clods of earth or a piece of old cane broken in half. Experiments showed that in Minnesota no further covering is necessary. Where the climate is more severe a furrow of earth is thrown over the canes with a plow and later it is smoothed by hand labor so that they are entirely covered.

The canes should be uncovered in the spring before growth starts, but not until after danger from severe weather has passed. Sometimes a gradual removal of the soil will be found advantageous. The canes will then become hardened by degrees, and there will be less danger of injury to the buds.

LENGTH OF LIFE OF THE PLANTATION

The factors which determine the number of years a plantation will be profitable are not entirely understood, but to a large extent the length of life of a plantation depends on the care given it. In the Puyallup Valley of Washington, some red-raspberry plantations that have been bearing good crops for 20, 25, and even 35 years show no signs of becoming less fruitful. In the eastern United States occasional raspberry fields nearly as old are still in good condition, and small bearing patches are much older. The canes in such fields have been thinned regularly, and the moisture supply has been kept up by constant cultivation and by furnishing a plentiful supply of humus. In the care ordinarily given the average plantation the moisture supply becomes deficient at times, and the new canes do not have an opportunity to develop as they should. Sometimes black and purple varieties

are allowed to bear so heavily that they cannot send up new canes, and such plants die. Often diseases and insects affect a plantation so that it becomes unprofitable. By systematic pruning, by supplying humus, by maintaining the fertility of the soil, and by constant cultivation the life of the plantation should be extended indefinitely. Perhaps the average length of life of a plantation in the Eastern States is 8 to 10 years for red raspberries and 6 to 8 years for black and purple ones.

HARVESTING

Raspberries should be handled as carefully as possible in harvesting, in order to avoid injuring them. The subsequent behavior of the fruit on the market depends in a large measure upon the care used in picking and handling. Berries injured or bruised in handling or soft from being overripe or from rainy weather are attacked quickly by certain mold fungi which cause their decay. To avoid as much injury as possible in picking, three fingers always should be used; very few berries should be held in the hand at one time; the berries always should be placed, not dropped, in the basket or cup; all decaying, over-ripe, and injured berries should be discarded; and no later handling of the berries in the basket should be allowed for any purpose.



Figure 25.—Waist and hand carriers. The waist carrier holds two cups or baskets and the hand carrier six. Because of the holes high up on the back of the waist carrier, it swings forward when the picker bends over.



Figure 26.—A picking carrier made to hold a quart basket. This carrier is suspended from the waist and is not likely to spill the berries when the picker is bending over. The filled baskets are placed in a hand carrier such as that shown.

Picking must be done at least two or three times each week, depending on the locality, the variety, and weather conditions. In the Northwest berries for the fresh-fruit market are picked three times a week but those for the cannery only twice weekly. In hot or wet weather picking may be required at least every other day. In the dry sections of the West every third or fourth day may be often enough. Some varieties rot on the bushes, the Cuthbert and King being especially bad in this respect. The Cuthbert turns dark quickly. The Newburgh crumbles if picked too green, while the Latham keeps well on the bushes.

Carriers used in packing are shown in figures 25 and 26. The berries should be picked into baskets in the waist carrier. As soon as the baskets are filled they should be transferred to the hand carrier, which always should stand in the shade.

In many sections the waist carrier holds two baskets, one for very ripe fruit and one for firm berries suitable for shipping. The very ripe fruit is used for canning and the firmer fruit for shipping to distant markets. When pickers are trained to use both baskets they lose very little time in the grading. Usually six to eight pickers per acre are needed in harvesting.

YIELDS

Yields from raspberry plantations vary greatly according to the varieties raised, the care given them, and the conditions under which they are grown. In the eastern United States it is agreed generally that in sections to which they are adapted the purple sorts are the most productive, the blackcaps next, and the red varieties the least productive. In the Northwest the red varieties are the most productive. The average yield for the United States is less than 1,000 quarts per acre. No grower, however, should be satisfied with such yields. Records of red-raspberry growers in New York indicate that the average yield of good fields is between 1,300 and 1,400 quarts per acre, whereas that of the best fields is as high as 4,000 quarts. Good fields of black raspberries in the same State average between 1,400 and 1,700 quarts per acre, and the purple varieties average between 1,700 and 2,300 quarts.

Yields in different sections as well as from different varieties vary greatly. In the Loveland district of Colorado the Marlboro variety has borne over 4,000 quarts per acre when the bushes were protected during the winter and other conditions were favorable. In the Puyallup Valley of Washington, a report gave the average yield of the 10 best fields of the Cuthbert as 7,500 quarts (11,250 pounds) per acre, though the average yields there are about 3,000 quarts (4,500 pounds) per acre. The Washington variety has given yields as high as 12,000 quarts (18,000 pounds) per acre in the Puyallup Valley and the Willamette as high as 9,300 quarts (14,000 pounds) per acre in Oregon. Eastern growers who have given their plantations care as intensive as is given in Washington have been getting yields nearly as large as those obtained in that State. In the Northwest, Cuthbert plants averaging seven canes each, the canes having a diameter of seven-sixteenths inch at 6 inches above the ground and a diameter at least 90 percent as great at 5½ feet above the ground, may be expected to give maximum yields. The yield decreases in

the same proportion that the diameter of the canes at 5½ feet decreases in comparison with the diameter at the base. The canes of the Marlboro and other sorts naturally taper more evenly.

PROPAGATION OF STOCK

Many growers having established plantations propagate their own stock. In order to produce new plants the canes of black and purple raspberries are bent over and the tips are buried to a depth of not less than 2 or more than 4 inches. This should be done when the tip is lengthening rapidly and bearing small curved leaves. Tips of the new canes take root quickly and rapidly develop into strong plants if they are pointed straight downward in loose moist soil.

By the following spring the tips will have rooted and formed good new plants. The old canes should then be severed, leaving 4 to 8 inches of cane, as shown in figure 3, on the new plants which are to be set in the field. In planting, however, this cane should be buried or cut off, leaving none of it above ground.

If the tips of the canes of black and purple varieties are pinched off when they are about 12 inches high, the canes will branch freely and produce a large number of tips for burying. For many growers the first harvest from both black and purple raspberry plantations is a crop of plants. In fact, a large number of the plants distributed by nurserymen are produced in this way by raspberry growers, who in turn sell them to nurserymen. As previously stated, the strongest tip plant will make by far the best growth and should be selected for planting.

Red raspberries send up new canes from the base of the old canes, as do black and purple varieties. In addition, they send up suckers from underground roots at various distances from the crown of the parent plant. In starting a new plantation the strongest of these suckers are used. If a quantity of plants for setting is needed each year for several years, it may prove desirable to take up all plants in a given part of the field, both the old ones and the suckers. By the following year a solid stand of plants suitable for setting will have sprung up from the pieces of roots left in the ground. When these are dug, another stand will grow for the following year if the ground is rich. If this practice is followed, the fruiting plantation need not be disturbed by digging up sucker plants. Sometimes growers wait until suckers appear in the spring and set these out. Such plants are small, but they make a rapid growth in cool cloudy weather and are very free from insects and diseases.

Raspberries may be propagated also by cuttings of the roots (red sorts), new canes (black sorts), or leaf buds (black sorts) if necessary. In ordinary practice, however, the cane cuttings and leaf buds are rarely used. Root cuttings are sometimes used in propagating red varieties.

VARIETIES, HYBRIDS, AND RELATED FORMS

SELECTION OF VARIETIES

The varieties of red raspberries under cultivation have come from different parts of North America and Europe and are adapted to different conditions of environment and to different uses. Thus, the

Sunbeam and Ohta, which originated in South Dakota, generally withstand the trying conditions of the cold winters there. The King, formerly a desirable variety throughout the region between the Mississippi River and the Appalachian Mountains, where raspberries succeed, now has been largely replaced by the more productive Latham, although the Latham is later. The Latham, originated by the Minnesota Agricultural Experiment Station, is hardy and is one of the most productive in all northern regions. It has become the leading red raspberry in much of the eastern United States.

In selecting the varieties of raspberries to cultivate in any locality it is usually important to consider the hardiness of the canes, the productiveness of the variety, and its fitness for the particular purpose for which the crop is to be used. In the characterizations here given, special attention has been paid to these points. Thus, if in western New York varieties are desired through a long season, the following may be selected: For an early red variety the June and for a late one the Latham or Taylor; for black varieties the Cumberland or the Bristol; and for a purple variety the Sodus. In the Middle West the list should include for red varieties the Chief or Sunrise and Latham and for black ones the Plum Farmer and Cumberland. In Oregon and Washington the Cuthbert is still grown, but the Washington is replacing it in Washington State and is being heavily planted, along with the Newburgh and Willamette, in Oregon. The Plum Farmer and Munger are the only blackcap varieties generally planted there now. In southern California the Surprise red raspberry has been considered the best variety, whereas in central California the Ranere is the principal sort. The seasons of ripening for these raspberries are given in the characterizations.

The varieties listed for the different sections are suggestive only, as in certain localities the varieties named may not prove equal to others. In the United States as a whole the Cuthbert was the leading red variety until about 1920. Growers seemed to prefer to plant a single variety rather than several varieties and commonly selected the Cuthbert, but the more productive Latham has supplanted it in most of the eastern United States.

In eastern districts there is now a shifting preference for varieties due largely to difficulties in disease control, thus making suggestions regarding them uncertain. Several new sorts are on trial. In New York the Taylor, Newburgh, and Latham are usually grown; in New Jersey the Latham and Ranere; in Michigan the Latham and Taylor; and in Minnesota the Latham.

If varieties suited to special uses are desired the following suggestions will prove helpful.

Certain varieties of red raspberries bear fruit on the young canes in late summer. The best-known variety having this characteristic is the Ranere, which is grown extensively in central California and to some extent in New Jersey. The Indian Summer has proved superior to the Ranere at some points in the Northeast and in Colorado. It has large fruit of high flavor. During seasons with rainy summers or under irrigation these varieties will produce considerable fruit in the late-summer and fall months, but when the moisture is deficient they cannot develop good fruit. Growers in New Jersey frequently market large quantities of fruit in August and September, and under conditions similar to those in New Jersey fall-fruited varieties are likely to prove

desirable. The September is a promising new variety in New York, maturing fruit on the young canes earlier in the fall than the Indian Summer does. The Tennessee Autumn is another promising new fall-fruited raspberry in Tennessee and the Durham still another in New Hampshire.

For jams and preserves the Cuthbert, Washington, Willamette, Columbian, and Potomac are especially desirable.

For canning the Cuthbert, Washington, and Willamette among the red sorts and the Cumberland and Bristol among the blackcaps are grown. Other varieties may be equally desirable for some localities, but the commercial industries are based largely on those just named.

Among the most desirable raspberries in cultivation at the present time are the ones described on pages 34 to 36.

DESCRIPTIONS OF VARIETIES

Red and Yellow Varieties

Chief (Minnesota 223).—Minnesota Agricultural Experiment Station origin. Berries medium-sized, bright red, medium firm, of good quality; early. Bushes among the hardiest of all commercial varieties, vigorous and productive. Standard early sort for upper Mississippi Valley region.

Cuthbert.—New York origin. Berries medium-sized, deep red, medium firm, of very good quality, hard to pick because hidden by leaves; late. Bushes only moderately hardy, suckering freely; canes very tall, limber, requiring support. Adapted to sandy loam, but doing well on a wide range of soil types. One of the best varieties for canning and preserving; formerly principal variety of Washington and Oregon, but being replaced by the Washington. Resistant to stem wilt (western bluestem).

Golden Queen.—New Jersey origin. Berries similar to those of the Cuthbert except for yellow color. Bushes very similar to those of the Cuthbert in all respects. Adapted to the same conditions as the Cuthbert. Desirable for home use and for amateurs.

Indian Summer.—New York Agricultural Experiment Station origin. Berries large, conical, deep red, soft and crumbly, with high flavor; early, young canes usually bearing another crop in September and October. Bushes moderately hardy, suckering freely. Liked especially near Denver, Colo. Escaping mosaic entirely; subject to leaf spot.

June (Ontario).—New York Agricultural Experiment Station origin. Berries large, bright red, firm, sometimes lacking in dessert quality; very early and long-seasoned. Bushes entirely hardy in the Eastern States, vigorous, almost thornless, suckering less than those of the Cuthbert. Adapted to heavy soils in New England, New York, Michigan, and Wisconsin.

King.—Virginia origin. Berries fairly large in sections to which the King is adapted, bright red, firm, dropping from bushes when overripe; early and long-seasoned. Bushes generally hardy, vigorous, productive on clay loams. Not generally desirable in New York and New England; largely replaced by the Latham.

Latham.—Minnesota Agricultural Experiment Station origin. Berries large, medium red, firm but often crumbly, of good enough quality to become the standard red variety of the eastern United States, but not of high quality; very late, later than the Cuthbert. Bushes hardy in eastern North Dakota, unusually vigorous, very productive (except in parts of New York and New England most productive variety wherever tested east of the Rocky Mountains), nearly thornless. Considered desirable for canning and freezing. Must be grown from mosaic-free stock; leaves subject to mildew; susceptible to wilt (western bluestem).

Newburgh.—New York Agricultural Experiment Station origin. Berries very large, bright red, firmer and of better quality than those of Latham. Planted somewhat in Northeastern States and Pacific Northwest. Susceptible to leaf spot and mildew; partially resistant to mosaic.

Ohta (Flaming Giant).—South Dakota Agricultural Experiment Station origin. Berries medium-sized, light red, soft, acid; very early. Bushes very hardy, vigorous, not very productive, prickly. Considered of some value in the northern Great Plains area and in other sections having severe winters, of no value in the Northeast.

Ranere (St. Regis).—New Jersey origin. Berries small to medium-sized, bright red, soft in the Eastern States, firm in California; very early and long-seasoned; after the old canes have borne, the young canes begin bearing and in New Jersey and California bear freely until frost. Bushes hardy, sending up suckers so freely that very thorough cultivation is necessary to keep them down. Long grown in New Jersey, where usually about five-sixths of the crop is borne in the spring and the rest in the fall; should be tested carefully before planting heavily in regions where it has not yet been tried, as it will bear little in the fall in some regions and not at all in the fall in some seasons of drought. Leading sort in central California, although susceptible to wilt (western blue-stem); susceptible to crown gall; resistant to virus diseases.

Sunbeam.—South Dakota Agricultural Experiment Station origin. Berries medium-sized, bright to dark red, fairly firm, acid; early. Bushes very hardy, promising in the northern Great Plains area where other varieties are not hardy, vigorous, fairly productive, prickly. Drought-resistant.

Sunrise.—United States Department of Agriculture origin. Berries medium-sized, bright red, fairly firm, of good quality; earliest in Maryland. Bushes very hardy, suckering freely. Grown chiefly in the South and Midwest. Resistant to leaf spot and anthracnose.

Surprise (California Surprise).—Probably California origin. Berries medium-sized, conical, bright red, fairly firm, of good quality; early. Bushes, hardiness not known, bearing in California a second good crop the first and second years after setting and a smaller second crop thereafter but with some fruit almost every month; canes slender. Most desirable variety at present for southern California.

Tahoma.—Washington Agricultural Experiment Station origin. Berries bright red, large, firm; early. Bushes hardy. Promising shipping variety in Pacific Northwest.

Taylor.—New York Agricultural Experiment Station origin. Berries very large, of high quality; late. Well-liked for freezing; seemingly more widely adapted than the Newburgh to Northwestern States; a leading variety in New York and New England.

Van Fleet.—United States Department of Agriculture origin. Berries medium-sized to small, pinkish red, soft, tart, of fair quality, with very small seeds; very late, after other varieties are gone. Bushes more vigorous than any other cultivated sort; tender. Adapted to the southern United States from Washington, D. C., to northern Florida. Recommended for the southern United States where other sorts cannot be grown; promising in the hot interior valleys of California. Resistant to common diseases, including molds of berries.

Viking.—Ontario Experiment Station origin. Berries large, somewhat conical, somewhat brighter red and slightly firmer than those of Cuthbert, but similar in flavor, much more easily picked than those of the Cuthbert; slightly earlier than Cuthbert. Slightly grown in Northern States.

Washington.—Washington Agricultural Experiment Station origin. Berries medium-sized to large, deep red, of high quality; late, season similar to that of the Cuthbert. Bushes much harder than those of the Cuthbert and replacing the Cuthbert for freezing, preserving, and canning in the Northwest.

Willamette.—United States Department of Agriculture and Oregon Agricultural Experiment Station origin. Berries very large, nearly round, medium-deep red, very firm, of good quality; midseason. Bushes harder than those of Cuthbert, vigorous, very productive, suckering freely. New variety for trial in Oregon and Washington, because of very large, unusually firm berries and productiveness. Adapted to freezing and canning.

Purple Varieties

Columbian.—New York origin. Berries very large, rather soft, crumbly, of good quality; late, about with the Cuthbert. Bushes usually hardy in the East, but not always hardy in the Middle West, very vigorous, very productive. For-

merly one of the best canning and preserving raspberries; not now recommended because stock badly affected with virus diseases.

Marion.—New York Agricultural Experiment Station origin. Berries very large, firm, of good quality; late. Increasing in popularity in the Northeast.

Potomac.—United States Department of Agriculture origin. Berries large, firm, tart; late and long-seasoned. Bushes among the hardiest of all in the North and among the best in the South, very productive. Berries among the best for canning and preserving.

Sodus.—New York Agricultural Experiment Station origin. Berries very large, fairly firm, of good quality; late. Not so disease-resistant as the Potomac in the South, but being planted in New York and New England.

Webster.—New York Agricultural Experiment Station origin; a new variety increasing in popularity in New York and Pennsylvania.

Black Varieties

Black Pearl (Pearl).—Missouri origin. Berries large, firm; early and short-seasoned. Bushes hardy. Grown chiefly in Kansas, Missouri, and Michigan. Desirable as a companion to the Cumberland in these States. Promising in the Maryland Agricultural Experiment Station tests.

Bristol.—New York origin, new. Berries large, high-flavored, hard to pick after rains; midseason. Widely grown in New York. Very susceptible to anthracnose.

Cumberland.—Pennsylvania origin. Berries very large, firm; midseason. Bushes usually hardy. More widely planted than any other black raspberry because of its productiveness and quality; frequently planted in New York with the Logan or Shuttleworth as early varieties.

Logan (New Logan).—Illinois origin. Berries medium-sized, of very good quality; a week earlier than the Cumberland. Liked for earliness in Eastern States.

Morrison.—Ohio origin, new. Berries largest of black varieties, firm, glossy, of fair quality; late. Bushes productive. Being tested in New York, Pennsylvania, and Ohio.

Munger.—Ohio origin. Preferred to other sorts by some in Oregon and Washington. Susceptible to mildew.

Naples.—New York Experiment Station origin, new. Berries medium-sized; late. Bushes not very productive.

Older.—Iowa origin. Berries medium-sized, rather soft. Bushes very hardy for a black variety, vigorous, of a somewhat trailing nature. Desirable for Iowa and Minnesota conditions.

Plum Farmer (Farmer).—Ohio origin. Berries large, firm; early and short-seasoned, ripening so quickly that the entire crop can be harvested in two or three pickings. Bushes hardier than those of most other blackcaps. Desirable for planting with the Cumberland in the Central States and Pacific Northwest. Drought-resistant.

Shuttleworth.—New York origin. Berries large, firm; very early. Grown chiefly in western New York.

HYBRID AND RELATED FORMS

Besides the Logan, Young, Boysen, and others of the same group there is at present in the trade in this country but one hybrid, the Ness, between the common forms of raspberry and blackberry; and there are no hybrids between the raspberry and other fruits. The Ness, which was originated at the Texas Agricultural Experiment Station, is the result of crossing the raspberry and a southern form of dewberry or blackberry. Although of high quality and productive, it is not likely to be of commercial value because the fruit cannot be picked off like the blackberry or pulled off like the raspberry; it mashes in the hand or must be clipped off with the cap and a piece of the stem attached. However, it is worth growing in the lower South for home use.

Several forms related to the raspberry are being propagated by the trade. Of these the form sometimes called the golden evergreen raspberry, or Himalayan golden raspberry (*Rubus ellipticus* J. E. Smith), comes from India and southern China and will thrive only in the subtropical climates of southern California and southern Florida. The bush is perennial and will grow to a height of 15 to 20 feet with a spread of 30 feet in a few years. Usually it does not begin to bear until it is 3 to 5 years old, but then it may sometimes bear annually more than 100 quarts per plant of golden-colored fruit about the size of a small black raspberry. The fruit is of only fair quality, but it may be of some value for home use in districts where other berries will not grow. Other forms widely advertised at times are the wineberry (*R. phoenicolasius* Maxim.), which is a native of Japan and China that bears cherry-red insipid fruit and is naturalized along the Atlantic coast from New England to North Carolina; the strawberry raspberry (*R. illecebrosus* Focke), a native of Japan bearing scarlet fruit of poor quality; and the Chinese raspberry (*R. xanthocarpus* Bur. and Franch.), a native of China bearing a small quantity of sweet yellow fruit. None of these forms has proved to be of commercial value.

The southern or Thunberg raspberry (*Rubus thunbergii* Sieb. and Zucc.), a native of China and southern Japan, has been introduced into the trade in southern Louisiana and Texas. It is rather closely related to the strawberry raspberry.

USES

A large part of the raspberry crop is marketed fresh, to be used in the home for various culinary and dessert purposes. In addition, large quantities are canned or are preserved by freezing. The commercial canned pack in the years 1925-35 averaged about 500,000 cases annually, valued at about \$1,000,000 per year, packed chiefly in Oregon, New York, Washington, and Michigan. The pack of Oregon and Washington consists primarily of red raspberries. This canned fruit is used largely for domestic consumption. No. 2 is the standard size can for packing raspberries.

Raspberries to be used for pie making, preserving, and other uses have been generally packed in the larger sized No. 10 cans. In recent years, however, fruit to be used in this trade is largely packed in barrels or large cans, either with or without sugar, and frozen.

Raspberries are also made into jams, jellies, and preserves, and quantities are used for making essences and extracts. The juice is sometimes expressed and sold for use as a beverage, and it is used also in the making of ice creams and sherbets.

Brief directions for utilizing raspberries follow.¹

Canning in tins.—Only cans that have been lacquered on the inside should be used for raspberries. Stems, leaves, and defective fruit should be discarded and the cans should then be filled with a certain weight of berries. Hot water or hot sugar sirup should be added, the can exhausted, the top inserted and sealed, and the whole can ster-

¹ For additional information on canning, see United States Department of Agriculture AWI-93, Home Canning of Fruits and Vegetables.

ilized. The sterilizing process takes 12 minutes at 212° F. If a sirup is added it should be of the right degree of density to bring out the flavor of the particular variety. Usually the density will range from 15° to 50°. A 50° sirup is made by adding 8 pounds 6 ounces of sugar to 1 gallon of water, and a 15° sirup is made by adding 1 pound $7\frac{1}{2}$ ounces to each gallon of water.

Canning in glass jars.—If there is no objection to shrinkage, the berries may be put in the jars, covered with a hot sirup of 15° to 50° density, and then sterilized for 20 minutes at 212° F. The covers should be fastened on immediately after cooking. If jars full of fruit are desired, the berries should be cooked before being packed in the jars and less sirup used.

Making jam.—For making jam the fresh berries may be thoroughly mashed or they may be left whole. If they are used whole, some water must be added before they are cooked; cooking will take longer than if no water is added. Ordinarily sugar equal in weight to the berries should be added before they are cooked. If the fruit is very acid more sugar should be used; if it is mildly acid less sugar will be needed. The jam should be cooked at 212° F. for 20 minutes or until it is of the desired thickness and then placed in jars and sealed.

Frozen storage.—From 16 to 22 million pounds of red and purple raspberries are frozen each year to be used fresh or by the pie, preserve, and ice-cream industries. The berries are picked over, washed if necessary, and put in barrels or smaller containers, usually with sugar. If with sugar, the proportion is 1 part of sugar to 2, 3, or 4 parts of berries, depending on the purpose for which they are to be used. The packages must be placed in freezing storage promptly. Since 1927 an increasing quantity has been frozen-packed in small containers for home consumption. These are mostly packed in the proportion of 1 part of sugar to 3 parts of berries.

DISEASES ² AND INSECTS

Several serious diseases of the raspberry are largely responsible for the decline in the production of this fruit in recent years. These are mosaics and other virus diseases, crown gall wilt (western blue-stem), and anthracnose. At the present time the control of these diseases is the most important factor in raspberry growing. Control of virus diseases and crown gall is effected through the planting of clean stock, and this stock has been difficult to obtain.

Insect enemies of the raspberry are sometimes very serious in certain localities, but they are of far less importance in the country as a whole than the diseases mentioned. Information regarding the control of diseases and insects may be obtained by writing to the nearest State agricultural college or to the United States Department of Agriculture at Washington 25, D. C., and furnishing specimens of the insects and the affected parts.

² For information on diseases see Farmers' Bulletin 1488, Diseases of Raspberries and Blackberries.